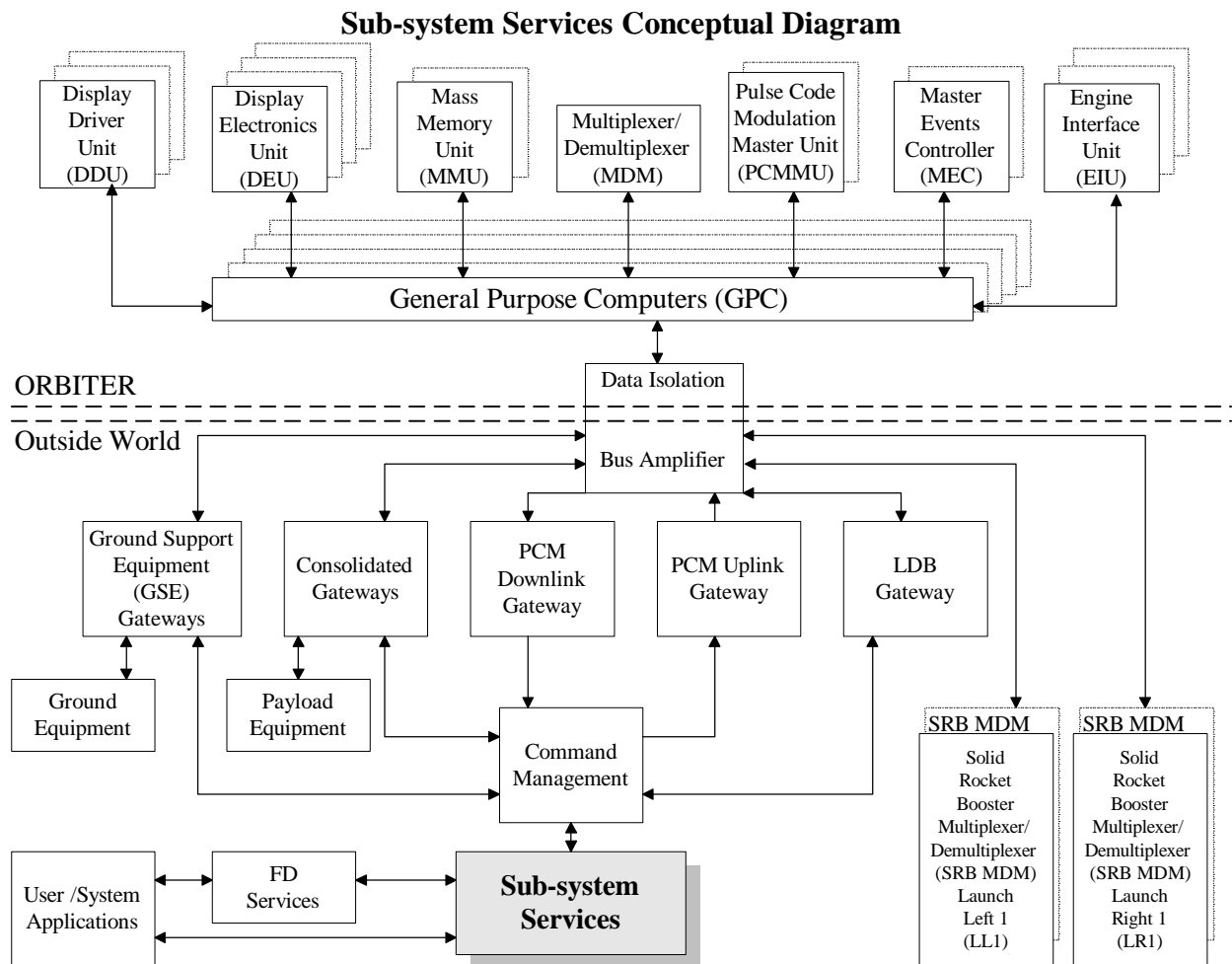


1. Sub-system Services (SSS) CSC

1.1 Sub-system Services Introduction

1.1.1 Sub-system Services Overview

Sub-system Services (SSS) is a CSC in Application Services (ASV). SSS consist of three parts, Ground Support Equipment (GSE) Application Services (GAS), On-board Services (OBS), and Non-gateway Services (NGS). GAS will be the interface for user applications to command Function Designators (FDs) and non-FDs to/from a GSE gateway. OBS will interface the commands for user applications for FDs and non-FDs from the Launch Data Bus (LDB) and Pulse Code Modulation (PCM) up-link and down-link gateways. Non-gateway Services will interface with commands that have a destination not associated with a gateway. This includes setting time FDs, health of an FD, constraints, etc..



1.1.2 Sub-system Services Operational Description

Sub-system Services (SSS) will be called from user and system applications. SSS will provide type checking C++ Application Programmers Interfaces (APIs) so that commands from an application are checked at compile and link time instead of run time. SSS commands will consist of two parts. FD related commands, and non-FD related commands. An FD Services object inherits FD commands from a sub-system class specific to the commands destination. This will provide data hiding and allow the object to only call a command that the FD is capable of. Non-FD commands will be able to be accessed through SSS directly, but will not include any commands associated with a FD. The sub-system command will have in the object the necessary information about the particular sub-system. This will provide the syntax checking necessary to ensure the correct command. SSS will then put all the

necessary parts of the command together to be sent out to Command Management. Command responses will then be returned to SSS to provide the information back to the FD, or to the application.

1.2 Sub-system Services Specifications

1.2.1 Sub-system Services Groundrules

- Command Management will provide all gateway communications and packet definition for Sub-system Services.
- User applications must use SSS to send commands, or use FD Services for FD commands which accesses SSS.

1.2.2 Sub-system Services Functional Requirements

1.2.2.1 On-board Services (OBS) Functional Requirements

- I. OBS shall provide support for enable and disable PCM processing.
- II. OBS shall provide support for enabling and disabling data acquisition on selected PCM FDs.
- III. OBS shall provide support for modification of calibration coefficients of PCM FDs.
- IV. OBS shall provide support for reading calibration coefficients of PCM FDs.
- V. OBS shall provide support for activating and inhibiting significant change checking.
- VI. OBS shall provide support for activating and inhibiting frame logging.
- VII. OBS shall provide support for changing or selecting the active PCM gateway.
- VIII. OBS shall provide support for changing Sync Bits in Error Count
- IX. OBS shall provide a method for building a raw data word for discrete, analog, and digital pattern measurement and stimulus data (KSC-LPS-OP-033-4 section 2.1 (TRANSLATE TO RAW DATA AND MERGE WITH)).
- X. OBS shall provide a method for converting a raw data word from onboard memory into measurement data (KSC-LPS-OP-033-4 section 2.2 (CONVERT RAW DATA)).
- XI. OBS shall provide functionality for an user application to issue quantity type data to the system under test (KSC-LPS-OP-033-4 section 3.1 (APPLY ANALOG)).
 - A. For a single analog command applied to a single analog FD.
 - B. *For a single analog command applied to many analog FDs.¹*
 - C. *For many analog commands applied to many analog FDs.*
- XII. *OBS shall provide functionality for an user application the ability to command an Engine Interface Unit (EIU) to perform the internal functions (KSC-LPS-OP-033-4 section 3.2.1):*
 - A. *Status Override (COMMAND EIU STATUS OVERRIDE).*
 - B. *Master Reset (COMMAND EIU MASTER RESET).*
 - C. *Wrap Test (COMMAND EIU STATUS OVERRIDE).*
- XIII. *OBS shall provide functionality to send a request to the Launch Sequence Functional Destination for controlling the terminal count to support (COMMAND LAUNCH SEQUENCE (KSC-LPS-OP-033-4 section 3.2.2)):*
 - A. *RS Auto Sequence Start (RS AUTO SEQUENCE START).*
 - B. *Hold (HOLD).*
 - C. *Recycle (RECYCLE).*
 - D. *Bypass of LO2 Overboard Bleed Valve CL A (BYPASS OF LO2 OVBD BLEED VLV CL A).*
 - E. *Bypass of LO2 Overboard Bleed Valve CL B (BYPASS OF LO2 OVBD BLEED VLV CL B).*

¹ The functionality to give bundled commands will probably be implemented in higher level software such as Control-Shell, or a data handler.

- F. *Bypass of LO2 Accumulator Re-circulation Valve OP (BYPASS OF LO2 ACCUM RECIRC VLV OP).*
- G. *Resume Count (RESUME COUNT).*
- H. *SRB FCS Hydraulic Verification Flag (SRB FCS HYDR VERIFICATION FLAG).*
- I. *Orbiter Vent Doors Override (ORBITER VENT DOORS OVERRIDE).*
- J. *Estimated Mass of Orbiter with External Tank (EST MASS OF ORBITER WITH ET).*
- K. *Aerosurface Drive Check (AEROSURFACE DRIVE CHECK).*
- L. *MPS/ET Low Level Sensor Disable Flag (MPS/ET LOW LVL SNCR DSBL WRD).*
- M. *LPS Go For Engine Start (LPS GO FOR ENGINE START).*
- N. *ET LH2 Low Level Sensor Disable Flag (ET LH2 LOW LVL SNCR DSBL FLAG).*
- O. *SRM Chamber Pressure Calibration Word (SRM CHAMBER PRESS CAL WRD).*
- P. *JTOY of Lift Off To (JTOY OF LIFT OFF TO).*
- XIV. OBS shall provide functionality to request an MDM or FLEX MDM to perform the internal functions (KSC-LPS-OP033-4 section 3.2.3):
 - A. Master Reset (COMMAND MDM MASTER RESET).
 - B. Perform BITE Tests 1, 2, 3, and 4 (COMMAND MDM BITE).
 - C. Load the BITE Status Register (COMMAND MDM BITE STATUS REGISTER).
 - D. Perform a Wrap Test (COMMAND MDM WRAP TEST).
- XV. OBS shall provide the functionality to communicate with the Master Event Controller BTUs and to command their test and control functions for (KSC-LPS-OP-033-4 section 3.2.4):
 - A. SIM PIC CAP Volt Enable (COMMAND MEC SIM PIC CAP VOLT).
 - B. Master Reset (COMMAND MEC MASTER RESET).
 - C. Wrap Test (COMMAND MEC WRAP TEST).
- XVI. OBS shall provide functionality to request the Sequence Control Assembly (SCA) to perform internal test functions to (KSC-LPS-OP-033-4 section 3.2.5):
 - A. Wrap Test (COMMAND SCA WRAP TEST).
 - B. BITE Status Register (COMMAND SCA BITE STATUS REGISTER).
- XVII. OBS shall provide functionality to request the up-link gateway to perform the specified functions (KSC-LPS-OP-033-4 section 3.2.6):
 - A. to execute an up-link request which has been loaded in the two-stage buffer by a previous statement (COMMAND UPLINK TWO STAGE BUFFER EXECUTE).
 - B. to clear a request in the two-stage buffer previously loaded by a procedure (COMMAND UPLINK TWO STAGE BUFFER CLEAR).
 - C. to request the up-link FEP to accept a 48 bit pre-formatted command data word and cause it to be issued to the onboard system (COMMAND UPLINK TO ISSUE).
- XVIII. OBS shall provide functionality to provide an issue statement to support commands to the on-board components (KSC-LPS-OP-033-4 section 3.2.7 (ISSUE)):
 - A. Multiplexer/Demultiplexer (MDM)
 - B. FLEX MDM.
 - C. MDM Serial IO Device.
 - D. Engine Interface Unit (EIU)
 - E. Sequence Control Assembly (SCA)
 - F. Maser Events Controller for critical and critical/non-critical operations.
 - G. MDM or FLEX MDM PROM sequence.
- XIX. OBS shall provide functionality to provide “read” operations on the on-board components (KSC-LPS-OP-033-4 section 3.3):
 - A. Engine Interface Unit (READ EIU)
 - B. Multiplexer/Demultiplexer (READ MDM)
 - C. Master Events Controller (READ MEC)
 - D. Pulse Code Modulation Master Unit (READ PCMMU).
 - E. Sequence Control Assembly (READ SCA).
 - F. Support a single FD to be read and stored in a single variables.
 - G. Support a single FD to be read and stored in multiple variables.²

² The functionality to support multiple FD handling may be implemented in a higher level such as Control-Shell or a data handler.

- H. *Support multiple FDs to be read and stored in multiple variables.*
- XX. OBS shall provide the capability to set discrete statements for MDMs, MEC, and FLEX MDMs for (KSC-LPS-OP-033-4 section 3.4 (SET)):
 - A. Support time intervals to issue a discrete command and issue the compliment when the time value specified has expired.
 - B. Support time interval to reissue the same state after the time interval has been exhausted (NO COMPLEMENT).
 - C. Support commands to receive high priority processing by the LDB FEP and routing to the SACS functional destination with responses inhibited (CRITICAL).
 - D. Support the up-link FEP to command data to be issued via the 2-stage buffer (MDM MULTIPLE).
 - E. *Support up-link FEP to cause a command data to be issued via the stored program command buffer and specify the JTOY at which the data is to be issued (AT TIME VALUE).*
 - F. Support to request the PCM up-link FEP to format a MDM single command for repeated issuance at the current system rate, and inhibit all other command processing until a STOP command is issued (REPEATED).
 - G. A single discrete command applied to a single FD.
 - H. A single discrete command applied to many FDs.
 - I. Many discrete commands applied to many FDs.
- XXI. OBS shall provide the functionality to cancel or terminate the execution of an on-board explicitly coded program (ECP) or TCS sequence (KSC-LPS-OP-033-4 section 4.1).
 - A. *Cancel the execution of an ECP (CANCEL ECP PROGRAM).*
 - B. *Cancel the execution of a TCS sequence (CANCEL TCS PROGRAM).*
- XXII. OBS shall provide the functionality to initiate the parallel execution of a TCS sequence or ECP in the GPC which is currently communicating with the ground via the LDB and support (KSC-LPS-OP-033-4 section 4.2 (CONCURRENT)):
 - A. *TCS sequence selected from mass memory and will continue as soon as the executor receives notification from the LDB FEP that the last data block of the sequence has been transferred to the GPC (TCS SEQUENCE FROM MASS MEMORY).*
- XXIII. OBS shall provide the functionality to initiate the execution of TCS Sequence (KSC-LPS-OP-033-4 section 4.3 (PERFORM TCS PROGRAM)).
- XXIV. OBS shall provide the functionality to restart execution of a previously stopped TCS sequence with an option to specify which TCS step number is to be used to re-start execution (KSC-LPS-OP-033-4 section 4.4 (RESUME TCS PROGRAM)).
- XXV. OBS shall provide the capability to temporarily halt the execution of a TCS sequence, to stop the execution of a repeated MDM single command in the PCM up-link gateway or to stop the execution of a repeated payload throughput command in the PCM up-link gateway (KSC-LPS-OP-033-4 section 4.5 (STOP TCS PROGRAM)).
- XXVI. OBS shall provide the functionality to issue statements to SRB MDM's to (KSC-LPS-OP-033-4 section 6.0):
 - A. *lock the MDM module specified in the data bank for the given FD (LOCK SRB MDM).*
 - B. *unlock the MDM module specified in the data bank for the given FD (UNLOCK SRB MDM).*
- XXVII. OBS shall provide the functionality to request the LDB FEP to enable the currently inactive LDB to provide the capability to switch LDBs when GPCs are polling simultaneously on both LDBs (KSC-LPS-OP-033-4 section 7.0 (SWITCH LDB)).
- XXVIII. OBS shall provide the functionality to provide the capability to control the LDB I/O functions performed by the GPC. This capability shall cause the desired request to be sent to the GPC which is currently communicating with the LDB gateway so that the current mode and/or control paths are changed by the GPC (KSC-LPS-OP-033-4 section 8.1 (LDB CONTROL)).
- XXIX. OBS shall provide the functionality to obtain the contents of on-board memory and store the data for (KSC-LPS-OP-033-4 section 8.2):
 - A. GPC memory (READ GMEM).
 - B. DEU memory (READ DEU MEM).
 - C. SSME memory (READ SSME MEM).
- XXX. OBS shall provide the functionality to modify locations in the on-board memory for (KSC-LPS-OP-033-4 section 8.3):

- A. GPC memory (WRITE GMEM).
- B. SSME memory (WRITE SSME MEM).
- XXXI. OBS shall provide the functionality to modify the value of data contained in the TCS 1-1 registers in the GPC numbered 49 through 96 without being required to specify the register's address (KSC-LPS-OP-033-4 section 9 (LOAD REGISTER)).
- XXXII. OBS shall provide the functionality to send values in the TCS 1-1 registers in the GPC numbered 49 through 96 to the ground without being required to specify the register's address (KSC-LPS-OP-033-4 section 10 (DUMP REGISTER)).
- XXXIII. OBS shall provide the functionality to emulate the DEU keystrokes and display data to the onboard CRT
 - A. Provide functionality to specify the value of a DEU type command in any of the permissible formats to the on-board system under test (KSC-LPS-OP-033-4 section 11.1 (ISSUE DEU)).
 - B. Provide functionality to display data from a ground API to the on-board DEU CRT (KSC-LPS-OP-03304 section 11.3 (RECORD DATA)).
- XXXIV. OBS shall provide the functionality to issue commands to the KU-Band Communications Radar or to payload systems that have Payload Signal Processors/Payload Interrogator (PSP/PI) or other special IO device interfaces and to issue commands to the Space-Lab subsystem or experimental computer (KSC-LPS-OP-033-4 section 14.1 (COMMAND PAYLOAD)).
- XXXV. OBS shall provide the functionality to command the Payload Data Interleaver (PDI) to perform the PDI Wrap Test (KSC-LPS-OP-033-4 section 14.2 (COMMAND PDI)).
- XXXVI. OBS shall provide the functionality to read data from the PDI (KSC-LPS-OP-033-4 section 14.3 (READ PDI)).
- XXXVII. OBS shall provide the functionality to issue CIE data and/or commands to the PCM uplink gateway for 128 KBS forward link command issuance (KSC-LPS-OP-033-4 section 14.4 (COMMAND CIE)).
- XXXVIII. OBS shall provide the functionality to (KSC-LPS-OP-033-4 section ()):
 - A. Activate/Inhibit Responses.
 - B. Activate/Inhibit MEC read BITE.
 - C. Activate/Inhibit read BITE.

1.2.2.2 GSE Application Services (GAS) Functional Requirements

- I. GAS shall provide support for an user application to issue quantity type data to a GSE gateway (APPLY ANALOG).
 - A. For a single analog command applied to a single analog FD.
 - B. For a single analog command applied to many analog FDs.
 - C. For many analog commands applied to many analog FDs.
- II. GAS shall provide support for an user application to set discrete statements to a GSE gateway (SET DISCRETE).
 - A. For a single discrete command applied to a single discrete FD.
 - B. For a single discrete command applied to many discrete FDs.
 - C. For many discrete commands applied to many discrete FDs.
 - D. To specify a time value to set the command to the indicated state for the specified period and then return it to the original state.
- III. GAS shall provide support for an user application to issue a value to digital pattern output FDs (ISSUE DIGITAL PATTERNS).
 - A. For a single digital pattern command applied to a single digital pattern FD.
 - B. For a single digital pattern command applied to many digital pattern FDs.
 - C. For many digital pattern commands applied to many digital pattern FDs.
- IV. GAS shall provide support for an user application to change the sample rate of any GSE FD.
- V. GAS shall provide a method for changing and reading calibration coefficients.
- VI. GAS shall provide a method for activating or inhibiting change processing on a per FD basis.
- VII. GAS shall provide a method of reading the current sample rate of an FD.
- VIII. GAS shall provide the capability to read the current hardware address of an FD.
- IX. GAS shall provide a method to activate or inhibit data acquisition at any GSE gateway.
- X. GAS shall provide a method to activate or inhibit data processing at any GSE gateway.

- XI. GAS shall provide a method to activate or inhibit command issuance by any GSE gateway.*
- XII. GAS shall provide a method to read the data acquisition status of any GSE gateway.*
- XIII. GAS shall provide change hardware address of an FD at any GSE gateway.*
- XIV. GAS shall provide a method to activate or inhibit command issuance*
- XV. GAS shall provide a method to read GSE HIM output FD.*
- XVI. GAS shall provide a method to activate or inhibit HIM testing Command.*
- XVII. GAS shall provide a method to activate or inhibit HIM polling command.*

1.2.2.3 Non-Gateway Services (NGS) Functional Requirements

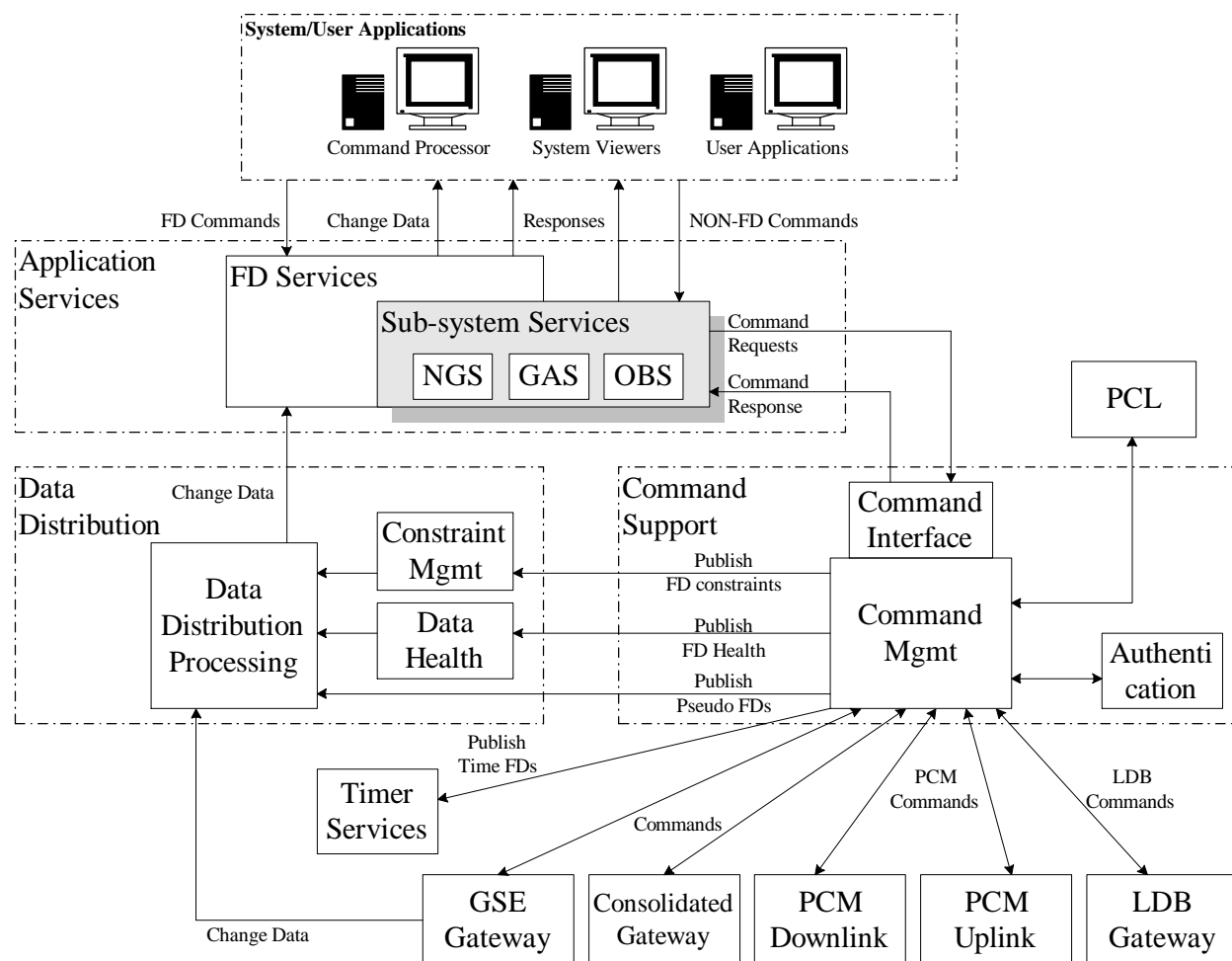
- I. NGS shall provide a method to publish values to pseudo FDs.
- II. NGS shall provide a method to publish health values for FDs using Command Management support.
- III. NGS shall provide a method to publish time values for time FDs using Command Management support for:
 - A. JTOY.
 - B. GMT.
 - C. CDT/MET.
- IV. NGS shall provide a method to publish constraints on an FD using Command Management support.

1.2.3 Sub-system Services Performance Requirements

There are no performance requirements for Sub-system Services.

1.2.4 Sub-system Services CSC Interfaces Data Flow Diagrams

External Data Flow Diagram Example



Sub-system services consist of objects tied into FD Services for a seamless integration of FD commands. When an application wants to perform an FD command, they will call an API through the FD object. The FD object will then have SSS package the command and send it out to Command Interface portion of Command Management. Command Interface will build the necessary packet to be sent out to the logical destination. Command Management will call the necessary Prerequisite Control Logic (PCL) and authenticate the command. The response code will be sent back to SSS to provide it for the FD object. If the command is associated with an FD object not assigned to a gateway, then Command Management will send it to the appropriate service to process the FD information as a command. If the command is not FD related, then the user will be able to create an object for the particular sub-system to call a command that is only associated with the appropriate destination. SSS will then package the command and send it to Command Interface to put the information into a packet to be sent through Command Management to the logical destination. Responses will then be sent back to SSS, and the service will provide any necessary conversions of the data to provide for the users similar capabilities found in the Ground Operations Aerospace Language (GOAL).

1.3 Sub-system Services Design Specification

1.3.1 Sub-system Services Detailed Data Flow

Detailed Data Flow Diagram

1.3.2 Sub-system Services External Interfaces

1.3.2.1 Sub-system Services Message Formats

1.3.2.2 Sub-system Services Display Formats

1.3.2.3 Sub-system Services Input Formats

1.3.2.4 Recorded Data

1.3.2.5 Sub-system Services Printer Formats

1.3.2.6 Interprocess Communications (C-to-C Communications?)

1.3.2.7 Sub-system Services External Interface Calls

1.3.2.8 Sub-system Services Name Table Formats

1.3.3 Sub-systems Services Test Plan